The Preejection Period (PEP) of the Fetal Cardiac Cycle during Hypoxemia

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The PEP is an index of left ventricular function and reflects changes in myocardial contractility, left ventricular end diastolic volume and aortic diastolic pressure. PEP decreases during positive cardiac inotropic states because isovolumetric contraction time shortens with increased myocardial contractility. In a previous study we described shortening of PEP after experimentally induced short periods of acute hypoxia in acute fetal lamb preparations (2). The purpose of this study was the investigation of changes in fetal PEP induced by longer periods of hypoxia under chronically instrumented conditions.

Fetal hypoxia was induced by reduction of the maternal arterial uterine blood supply by inflating a vascular occluder around the common internal iliac artery over a period of up to 18 hours. 8 ewes were operated at known fetal gestational ages of 12o-13o days. A catheter was passed into the fetal aorta via a carotid artery. Two fetal ECG electrodes were fixed to fetal skin. Experiments started after a recovering time for at least 3-4 days. The fetal ECG signal was recorded directly on a cardiotokograph. The analog pressure and ECG signals were recorded continuously on magnetic tape and lateron played back on a strip chart recorder for calculating of PEP. Immediately after each fetal PEP recording blood samples were withdrawn for determination of pH and respiratory gas tensions. In this study PEP was defined as an interval from the R-wave of the ECG signal to the onset of the upstroke of fetal arterial pressure. These intervals were measured manually on the tracings (1oo mm/sec. paper speed) and mean and standard deviations were calculated from 5 consecutive fetal cardiac cycles. After a stable baseline recording the externally controllable device for compressing the maternal internal iliac artery was inflated.

PEP increased with R-R-intervals between 24o and 56o msec. That means that PEP is inversely related to fetal heart rate. Because of the influence of heart rate on PEP correction with reference values must be made for valid comparison of results. We chose 14o bpm corresponding to R-R-interval of 429 msec. as the reference value for heart rate and obtained for PEP 429 the following correction formula:

$$PEP\ 429 = PEP - o{,}o82\ (RR-429)$$

0300-5577/82/0102-0046 $ 2.00

Using this equation for PEP 429 at different degrees of hypoxemia and acidosis a poor correlation was obtained between the rate corrected PEP and pH or pO_2 values of fetal arterial blood. This is due to the individual fluctuation of PEP. The influence of hypoxemia on fetal PEP becomes more evident of the relationship between PEP and R-R-intervals during normoxic and hypoxic conditions are examined. In 12 of 13 experiments with reduction of uterine blood supply a shortening of PEP was found during hypoxia in the range of R-R-intervals greater than 5oo msec.
According to Evers (1) alpha-adrenergically induced peripheral vascoconstriction, which leads to increase of arterial blood pressure as the primary response and to a fall in heart rate as a secondary response due to the baro-receptor reflex, seems to be the main determing factor in the fetal readjustment during hypoxia. Shortening of PEP is attributed to the effect of hypoxia to the adrenal medulla which reacts with secretion of catecholamines. Myocardial contractility increases because of the predominance of the catecholamine effect over the direct action of acute hypoxia in the myocardium. Chronic deterioration of the fetal conditions like longer lasting hypoxemia up to 18 hours reflected in a slowly progressive prolongation of fetal PEP back to baseline values. This possibly may be due to an impairment of fetal cardiac muscle function.

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